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ABSTRACT

The purpose of this study was to replicate the study conducted by Potter, Sagraves, and McDonald to determine whether their recommended analysis could separate criterion variables into similar factors that were stable from year to year and from school to school. The replication samples consisted of all students attending Louisiana State University School of Dentistry during the 1979-83 academic years. The sample included 76 freshman, 88 sophomores, and 92 juniors (total N-256). The variables assessed consisted of all courses taken during their freshman, sophomore, and junior years. The courses included lecture, preclinical, and clinical courses. The method chosen to validate the basic ability groupings was factor analysis, using principal component analysis and rotating the obtained factors through verimax rotation analysis. This was accomplished using the Statistical Package for the Social Sciences program, Factor Analysis. A criterion of .50 was used to replicate the chosen factor loading in the study. The results, unlike those of Potter et al., failed to separate criterion variables into similar basic ability factors. For four freshman classes, no consistent pattern appeared. For three sophomore classes and two junior classes, only suggestions and possible patterns were present. (Author)

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# DERIVED BASIC ABILITY FACTORS: A FACTOR ANALYSIS REPLICATION STUDY

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Paper presented at the Thirteenth Annual Meeting of the Mid-South Educational Research Association, New Orleans, Louisiana, November, 1984.

## ABSTRACT

The purpose of this study was to replicate the study conducted by Potter *et al.* to determine whether their recommended analysis could separate criterion variables into similar factors that were stable from year to year and from school to school.

The replication samples consisted of all students attending Louisiana State University School of Dentistry during the 1979-83 academic years. The sample included 76 freshman, 88 sophomores, and 92 juniors (total N = 256). The variables that were assessed consisted of all courses taken during their freshman, sophomore, and junior years. The courses included lecture, preclinical, and clinical courses.

The method chosen to validate the basic ability groupings was factor analysis, using principal component analysis and rotating the obtained factors through varimax rotation analysis. This was accomplished using the Statistical Package for the Social Sciences program, Factor Analysis. A criterion of .50 was used to replicate the chosen factor loading in the study.

The results, unlike those of Potter *et al.*, failed to separate criterion variables into similar basic ability factors. For four freshman classes, no consistent pattern appeared. For three sophomore classes, and two junior classes, only suggestions and possible patterns were present.

## INTRODUCTION

The need for replication studies has been well documented, although few have appeared in educational literature.[1-5] This failure to replicate studies is even more evident in dental education where they are almost non-existent.

The reason for conducting repeated studies in education has been nicely summarized by Bauernfeind.[1] He indicates that four of the most salient errors in replications include administrative, computational, sampling, and population errors. Of these problems, perhaps sampling errors most affect dental education studies, where much of the research is conducted at individual schools. By replicating experiments with different subjects and in different places, one's ability to generalize is increased. Conversely, when the study fails to be replicated, generalizability is decreased. This need for independent validation of samples has been underscored by the National Academy of Sciences, which called for professional schools to independently validate predictor variables for admission purposes.[6]

Recently, Potter, Sagraves, and McDonald utilized factor analysis to examine the underlying factors which may be present in a set of grades.[7] Although factor analysis has been employed in data analysis of predictor variables in dental education in the past, it has not been utilized to examine criterion variables. The Potter et al. study utilized factor analysis to determine whether an underlying group of factors existed in students' grades and to determine whether a grade was associated with more than one factor. Their results indicated:

> that overall performance is associated with factors that may be identified as basic science, dental science, and manual skill. The dental science factor appears to be developed during professional training and tends to be less clearly defined than the basic science and manual skills factors. While the didactic and laboratory courses are closely related to the science and manual skills factors, respectively, the associations of clinical course grades with the defined factors are generally low, reflecting the complex involvement of dental clinic performance. It is reasonable to speculate, therefore, that dental school grades, when compounded together as overall GPA across the basic abilities of the students, constitute a likely source of variation that accounts for difficulties in prediction studies when they are used as criterion variables.[7]

The results of the Potter et al. study prove interesting. However, they are suspect without replication because of the specificity of the sample. Hence, the purpose of this study was to replicate the previously mentioned study to determine whether their recommended analysis could separate criterion variables (i.e., course grades) into similar factors that were stable from year to year and, more importantly, from school to school.

## METHOD

The replication sample consisted of all students attending Louisiana State University School of Dentistry during the 1979-83 academic years. The sample included 76 freshman, 88 sophomores and 92 juniors (total N = 256). The assessed variables consisted of all courses taken during all years, including lecture, preclinical, and clinical courses.

The original sample used in Potter's study consisted of two graduating classes at the Indiana University School of Dentistry. One

hundred and twenty-three students from the 1980 and 133 from the 1981 graduating classes participated.

Replication followed the same methodology described by Potter et al.: simple correlations were calculated among all courses for each class for each year. The simple correlation matrix was subjected to principal component factor analysis and then to varimax rotation using the Statistical Package for the Social Sciences program, Factor Analysis.[8] Only those courses which loaded .50 or greater were retained for interpretation.

## RESULTS

Table 1 indicates the results of the analysis. As can be seen from the table, five of the fourteen courses load on Factor 1 for the 1979-80 freshman year. The course included in this factor are Removable Partial Dentures, Oral Diagnosis I, Preventive Dentistry, Principles of Human Behavior, and Dental Materials. These courses do not load consistantly as a group on Factor 1 for the remaining three freshman classes.

In relationship to Factor 2, five courses also load it for the 1979-80 freshman year. They include Operative Dentistry, Removable Partial Dentures, Morphology and Occlusion, Dental Occlusion, and Dental Materials. However, like in Factor 1, no consistant factor pattern emerges for the remaining three freshman classes. The loadings either fall below the .50 criterion level or move to another factor.

Factor 3 of the 1979-80 freshman year is composed of three courses. They include Gross Anatomy, Micro-Anatomy, and Biochemistry. This factor, like the two previous ones, does not remain stable over the next three classes.

Table 1 also indicates the data from the three sophomore classes. As can be seen from the table, five of the 20 courses load on Factor I for the 1979-80 sophomore class. The courses include Microbiology, General Pathology, Complete Dentures, Exodontia, and Preclinical Endodontics. Only Microbiology and General Pathology continue to load together in a consistent fashion for an additional two years indicating a weak basic science factor.

With regard to Factor 2, three courses load on it for the 1979-80 class. They include General Pathology, Oral Diagnosis II, and Occlusal Equilibration. However, they do not continue to load consistantly as a group for the remaining two years.

In relationship to Factor 3, three courses also load on it for the 1979-80 class. They include Preclinical Fixed Prosthodontics, Special Denture Techniques, and Inlay Techniques. Of those three courses, only Preclinical Fixed Prosthodontics and Inlay Techniques load consistantly on a smilar factor for the remaining two years.

Lastly, Table 1 indicates the two junior classes tested. Factor 1 for the 1979-80 junior class included seven courses. They were Pharmacology, Oral Pathology, Pedodontics, Advanced Oral Surgery, Oral Medicine, Internal Medicine, and Pain Control II. All of these courses load together on the same factor in the second year tested.

Factor 2 of year 1979-80 is composed of two courses; Pedodontic Clinic and Oncology. Only Pedodontic Clinic reappears in the 1980-81 school year.

With regard to Factor 3, two courses load on it for the 1979-80 school year. They are Endodontics II and Oral Diagnosis II. Neither of these courses load at the .50 criterion level in the following year.

## DISCUSSION

The purpose of this study was to replicate a factor analytic study of course grades conducted by Potter *et al*. The results of the replication clearly indicate the absence of any factors resembling those found in their study. Several reasons for the discrepancies seem possible.

First, Louisiana State University School of Dentistry may teach differently than Indiana University School of Dentistry. This could change the factors present in the Louisiana courses, and might eliminate the factors found by Potter *et al*.

Second, instructional techniques may change over time. This might change the factor groupings for different classes. Such an occurrence could obscure any basic factors from appearing in data from different academic years. Such may have been the case for our four freshman classes and three sophomore classes.

Third, examining only two classes at any school may reveal spurious factors. This length of time does not guarantee that any factors found will remain the same in subsequent classes. This would be the case for the slight evidence we obtained for the two junior classes examined, and for Potter *et al*.'s results in examining only two years.

Fourth, we only examined 76 freshmen, 88 sophomores, and 92 juniors. These numbers are small considering the large standard errors of factor loadings, and could effect both our results and those of Potter *et al*. A general rule of thumb is to use ten subjects for each variable.[2]

The first three of the above considerations may imply that no basic ability factors remain stable from year to year and from school to

school. The fourth consideration implies that future studies will require greater sample sizes.

In summary, such variations in subjects, teaching methods, course requirements and grading procedures suggest a critical need for more replication studies using factor analysis. When purporting to define common factors from a large set of variables, the statistical significance of the variables becomes much more practical when such factors are identified in large and varied samples.

TABLE 1

VARIMAX ROTATED FACTOR LOADINGS OF DENTAL COURSE GRADES

| | Year 79-80 | | | | Year 80-81 | | | | Year 81-82 | | | | Year 82-83 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Factor 1 | 2 | 3 | 4 | Factor 1 | 2 | 3 | 4 | Factor 1 | 2 | 3 | 4 | Factor 1 | 2 | 3 | 4 |
| **FRESHMAN COURSES** | | | | | | | | | | | | | | | | |
| Gross Anat. | 01 | 30 | 72 | | 68 | 18 | 20 | | 45 | 57 | -12 | 18 | 55 | 22 | 41 | -13 |
| Micro Anat. | 30 | 04 | 79 | | 81 | -01 | 21 | | 83 | 09 | 17 | 20 | 30 | 06 | 55 | 04 |
| Biochemistry | 37 | 20 | 61 | | 27 | 36 | 54 | | 66 | -02 | 24 | 31 | 79 | -14 | 36 | 08 |
| Operative Dent. | 26 | 54 | 15 | | 55 | 24 | 08 | | 11 | 38 | 08 | 61 | 15 | 63 | 18 | 11 |
| R. P. D. | 54 | 52 | 15 | | 34 | 61 | 39 | | 32 | 10 | 43 | 5[illegible] | 40 | 57 | -06 | 10 |
| Oral Diag. I | 51 | 31 | 19 | | 41 | 33 | 50 | | 34 | 45 | 21 | 0[illegible] | 49 | 24 | 36 | -00 |
| Dent. Rad. | 49 | 22 | 11 | | 27 | 12 | 68 | | -02 | 60 | 35 | 12 | 14 | 18 | 47 | 24 |
| Growth & Dev. | 45 | 30 | 29 | | 09 | 35 | 64 | | 35 | 29 | 26 | -09 | 14 | 07 | -03 | 09 |
| Prevent. Dent. | 67 | 26 | 12 | | -09 | 69 | 28 | | 23 | 30 | 71 | 08 | 55 | 15 | 49 | 49 |
| P. Hum. Beh. | 56 | 08 | 23 | | 12 | 47 | 28 | | 54 | 18 | 37 | -15 | 16 | 30 | 27 | 52 |
| Morph. & Occ. | 10 | 71 | 20 | | 71 | 07 | 17 | | 04 | 75 | 02 | 15 | 01 | 68 | 07 | 18 |
| Denture Occ. | 33 | 51 | 09 | | 32 | 51 | 03 | | 09 | 45 | 18 | 07 | 03 | 65 | 27 | 17 |
| Dent. Maters. | 50 | 56 | 23 | | 36 | 46 | 29 | | 52 | 42 | 18 | 23 | 63 | 28 | 27 | 26 |
| Crow. Scale. | 41 | 44 | 11 | | 49 | 28 | 23 | | 24 | 07 | 59 | 18 | 00 | 18 | 13 | 45 |
| **SOPHOMORE COURSES** | | | | | | | | | | | | | | | | |
| Microbiology | 60 | 21 | 09 | 09 | 53 | 43 | 04 | | -00 | 26 | 74 | 14 | | | | |
| Physiology | 41 | 46 | 00 | 13 | 87 | 20 | 32 | | 06 | 12 | 63 | -06 | | | | |
| Gen. Path. | 54 | 56 | -18 | 08 | 76 | 19 | 03 | | 04 | 13 | 62 | 30 | | | | |
| PC Fix. Pros. | 10 | 11 | 65 | 11 | -04 | 23 | 50 | | 56 | 08 | 04 | 09 | | | | |
| Comp. Dentur. | 58 | 00 | 42 | 17 | 15 | 13 | 45 | | 52 | 28 | 16 | 01 | | | | |
| Spec. Dentur. Tec. | 27 | 22 | 64 | 10 | 19 | 48 | 46 | | 35 | 50 | 13 | 24 | | | | |
| R. P. D. | 41 | 07 | 14 | 18 | 25 | 66 | 18 | | 35 | 59 | 08 | -13 | | | | |
| Inlay Tech. | 17 | 06 | 52 | 27 | 13 | 11 | 94 | | 69 | 08 | -07 | 03 | | | | |
| Cl. O. Dent. | 22 | 01 | 20 | 74 | 06 | -06 | 28 | | 46 | -05 | 13 | 54 | | | | |
| Intro. Perio. | 22 | 40 | 31 | 53 | 32 | 45 | 17 | | 13 | 05 | 40 | 25 | | | | |
| Oral Diag. II | 04 | 73 | 12 | 11 | 34 | 37 | 10 | | -02 | 30 | 21 | 76 | | | | |
| Diag. Rad. | 31 | 39 | 23 | -11 | 45 | 36 | 17 | | 33 | 13 | 26 | 22 | | | | |
| Exodontia | 50 | 32 | 26 | 12 | 13 | 20 | -02 | | 05 | 44 | 20 | 19 | | | | |
| DAU I | -14 | -06 | 18 | 04 | 09 | 01 | 17 | | 27 | 03 | -15 | 04 | | | | |
| Treat Plan. | 34 | 24 | 18 | 00 | 15 | 22 | 08 | | 14 | 43 | 07 | 13 | | | | |
| Dent. Hist. | 38 | 16 | -19 | 06 | 22 | 40 | 09 | | -05 | 05 | 02 | -03 | | | | |
| Occ. Equil. | 40 | 52 | 43 | 06 | 25 | 70 | 20 | | 65 | 36 | 14 | 27 | | | | |
| Pain Cont. I | 44 | 16 | 20 | 26 | 57 | 27 | 01 | | 01 | 11 | 26 | 02 | | | | |
| Cl. App. Nutr. | 27 | 40 | 23 | 04 | 44 | 39 | 31 | | 03 | 47 | 18 | 26 | | | | |
| PC Endo | 53 | 24 | 36 | 19 | 31 | 39 | 31 | | 16 | 52 | 28 | 12 | | | | |

| | Year 79-80 | | | | Year 80-81 | | | | Year 81-82 | | | | Year 82-83 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Factor 1 | 2 | 3 | 4 | Factor 1 | 2 | 3 | 4 | Factor 1 | 2 | 3 | 4 | Factor 1 | 2 | 3 | 4 |
| **JUNIOR COURSES** | | | | | | | | | | | | | | | | |
| Pharmacology | 71 | -05 | 25 | 10 | 75 | 26 | -05 | -28 | | | | | | | | |
| Oral Path. | 61 | 29 | 05 | 15 | 85 | 31 | 10 | -01 | | | | | | | | |
| PC Ortho. | 29 | 16 | 23 | 61 | 36 | 49 | 13 | 15 | | | | | | | | |
| Pedodontics | 54 | 16 | 47 | 16 | 64 | 37 | 11 | 05 | | | | | | | | |
| Adv. Rem. Pros. | 43 | 46 | 19 | 40 | 50 | 16 | 14 | -07 | | | | | | | | |
| Cl. Rem. Pros. | 00 | 29 | 31 | 37 | 00 | 37 | 42 | 19 | | | | | | | | |
| Adv. Cl. Oper. | 21 | 15 | 30 | 19 | 22 | 21 | 95 | -09 | | | | | | | | |
| Adv. Perio. | 39 | 35 | 25 | 16 | 39 | 50 | 01 | 16 | | | | | | | | |
| Cl. Fx. Pros. | 20 | 24 | 14 | 08 | 22 | 66 | 13 | -16 | | | | | | | | |
| Pedo. Cl. | 25 | 56 | 06 | 21 | 24 | 54 | 11 | 13 | | | | | | | | |
| Endo. II | 15 | 23 | 65 | 10 | 28 | 59 | 18 | -12 | | | | | | | | |
| Adv. O. Surg. | 59 | 17 | 11 | 32 | 78 | 17 | 07 | 08 | | | | | | | | |
| Cl. Ortho. | 00 | 10 | 10 | 09 | 04 | 06 | -04 | 04 | | | | | | | | |
| Oral Diag. II | 19 | 07 | 67 | 09 | 27 | 37 | 36 | 15 | | | | | | | | |
| Dent. Rad. III | 49 | 04 | 17 | 15 | -05 | 29 | 06 | 11 | | | | | | | | |
| Com. & Prev. | -02 | 48 | 08 | 02 | 09 | 49 | 05 | -07 | | | | | | | | |
| Oncology | 43 | 60 | 13 | 07 | 52 | 16 | -07 | 22 | | | | | | | | |
| O. Med. | 59 | 14 | 08 | 20 | 68 | 05 | 08 | -14 | | | | | | | | |
| Inter. Med. | 69 | 22 | 03 | 00 | 66 | -07 | 07 | -11 | | | | | | | | |
| TMJ | 22 | 03 | 02 | 48 | 73 | 39 | 23 | 14 | | | | | | | | |
| Pain Cont. II | 75 | -01 | 06 | 08 | 58 | 30 | 17 | 17 | | | | | | | | |
| Cl. Surg. | 03 | 02 | 11 | 03 | -04 | 00 | 03 | 69 | | | | | | | | |

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